Accelerating Climate Simulations Through Hybrid Computing

Unconventional multi-core processors, such as the IBM Cell Broadband Engine (Cell/BE) and NVIDIA graphics processing units, have emerged as accelerators in climate simulation. However, climate models typically run on parallel computers with conventional processors (such as Intel and AMD) using Message Passing Interface (MPI).

We took on the challenge of connecting accelerators to parallel computers efficiently and easily—a critical issue for improved climate simulation. When using MPI for this connection, we identified two challenges: Identical MPI implementation is required in both accelerators and parallel computers; and existing MPI code must be modified to accommodate the accelerators.

To address these challenges, we implemented IBM Dynamic Application Virtualization (DAV) technology in a hybrid computing prototype system comprising two blades—each with two Intel quad-core processors and two IBM QS22 Cell blades connected with InfiniBand, allowing for seamless offloading of compute-intensive functions to remote, heterogeneous accelerators in a scalable, load-balanced manner. The NASA Center for Computational Sciences provided the hybrid computing system, as well as expertise in configuring the system and software.

For this project, a solar radiation component from a NASA climate model running with multiple MPI processes was offloaded to multiple Cell blades with a significant speedup. A Cell processor with 8 Synergistic Processing Elements is about 17 times faster than one core of an Intel Harpertown processor. The reduced computing time will lead to improvements in climate understanding and predictability.

The IBM Cell/BE has been rated one of the greenest computing platforms—effectively utilizing this system or other accelerators will reduce the large cooling cost of computing systems.
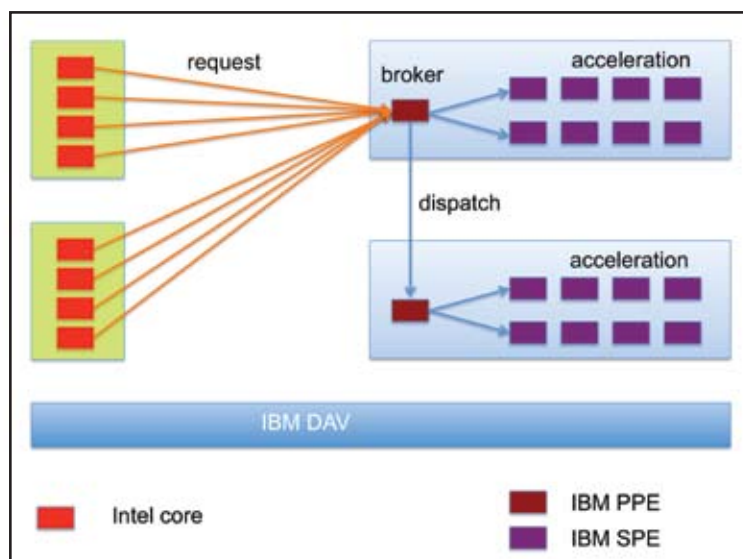
In the hybrid climate modeling system, compute-intensive functions can be offloaded from Intel multi-core processors to IBM Cell/BE through the Service Broker of IBM Dynamic Application Virtualization software.

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